National University of Sciences and Technology (NUST)

Digital Image Processing


What are your expectations?


What should be my expectations?

What do you want to learn in this Class?

Ground rules

Schedule

- **Office Hours**

  – Tuesday 2:00pm - 4:00pm
  or By Email

- **Attendance**

  - Minimum 75% to take the final exam.

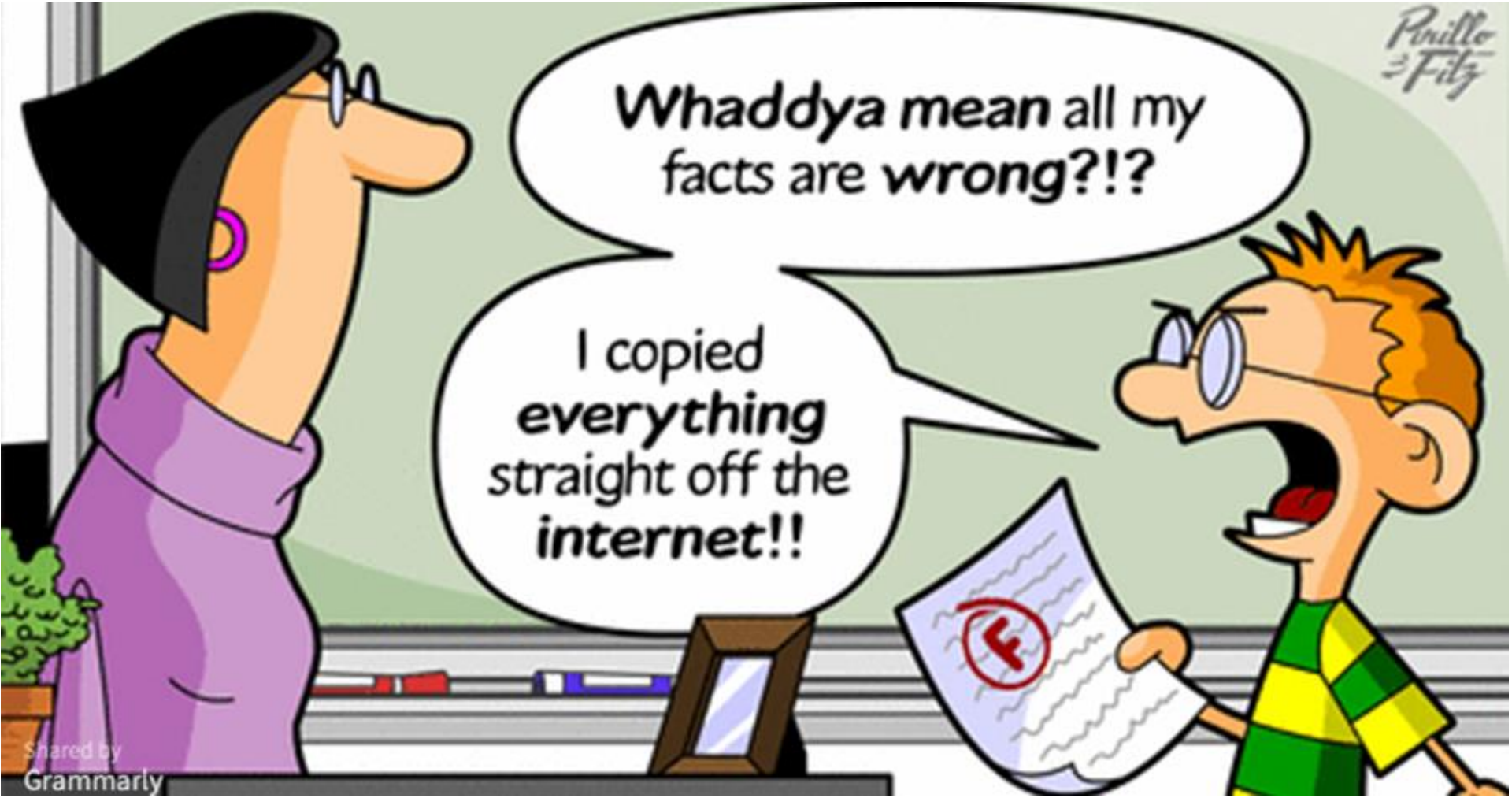
Distribution - Tentative

- Quizzes 5-10%
- Assignments 5-10%
- OHTs 30%
- Project 10-20%
- Final 35-40%

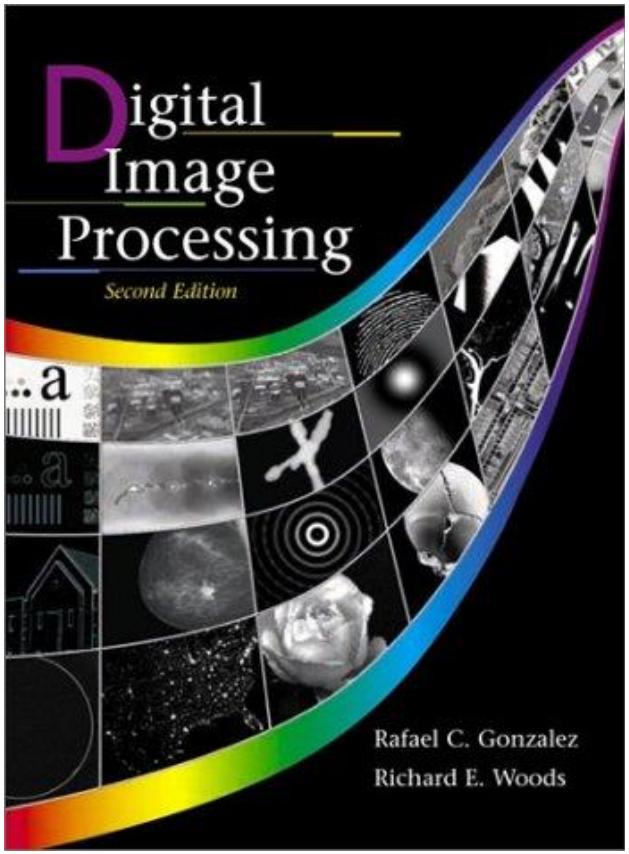
Plagiarism

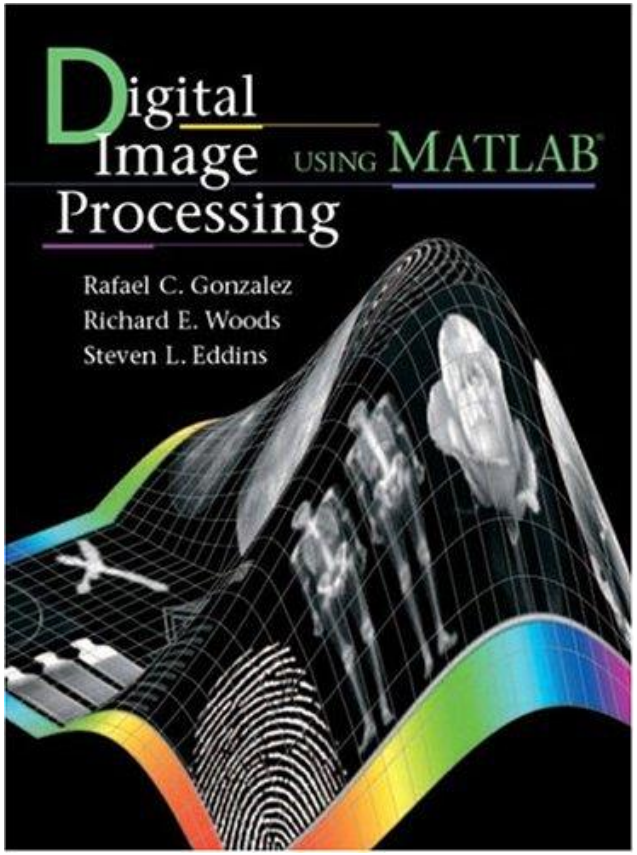

PLAGIARISM:
an act of presenting another person's work or idea as your own.
Buzzle.com

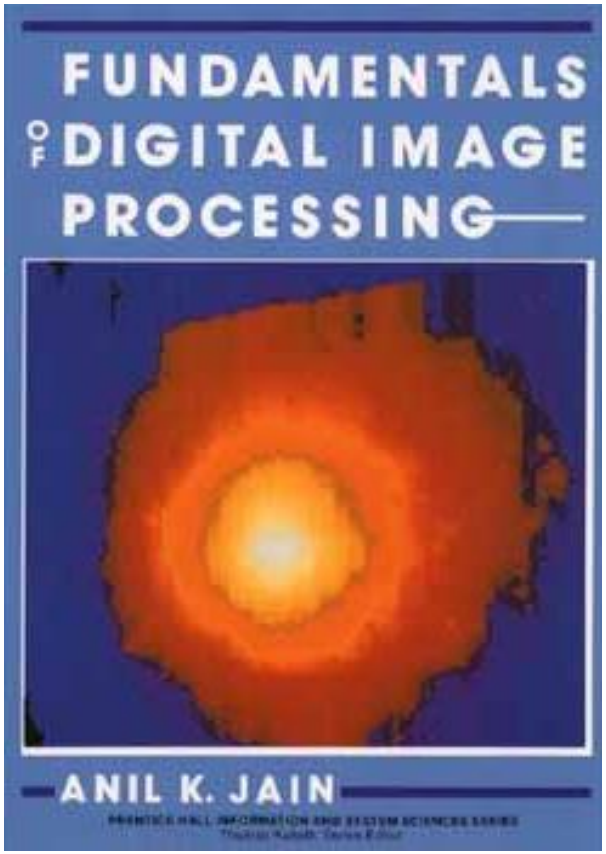
Plagiarism


Whaddya mean all my facts are wrong?!?
I copied everything straight off the internet!!
F
Shared by Grammarly

ADIP - Books


Digital
Image
Processing
Second Edition
Rafael C. Gonzalez
Richard E. Woods


Digital
Image Processing
USING MATLAB
Rafael C. Gonzalez
Richard E. Woods
Steven L. Eddins


FUNDAMENTALS
OF DIGITAL IMAGE
PROCESSING
ANIL K. JAIN

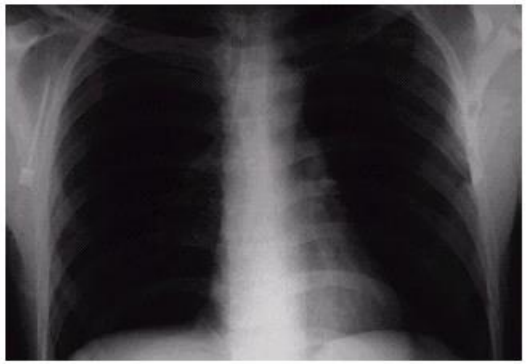
Python

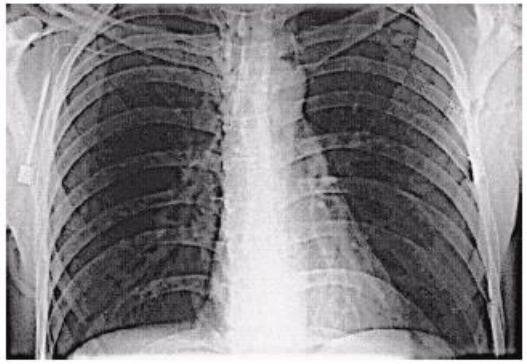
Vs

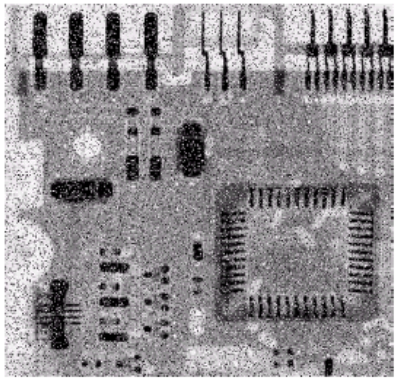
Matlab

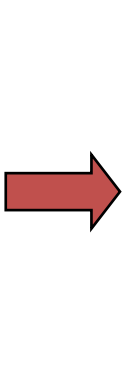
Applications
Of
Image Processing

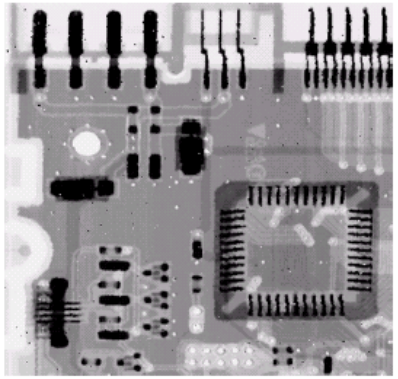
Contrast Enhancement











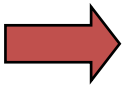
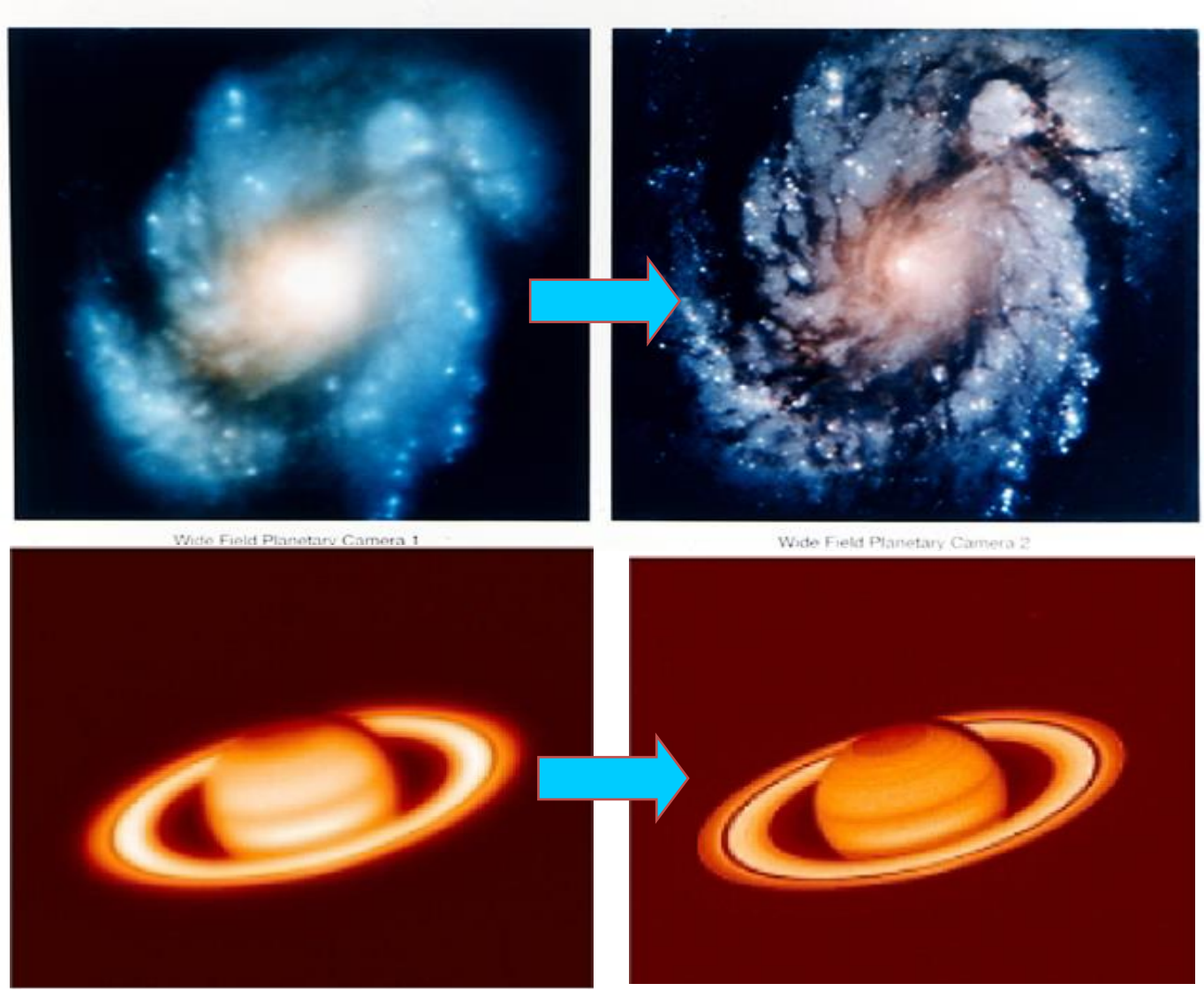


Image Sharpening



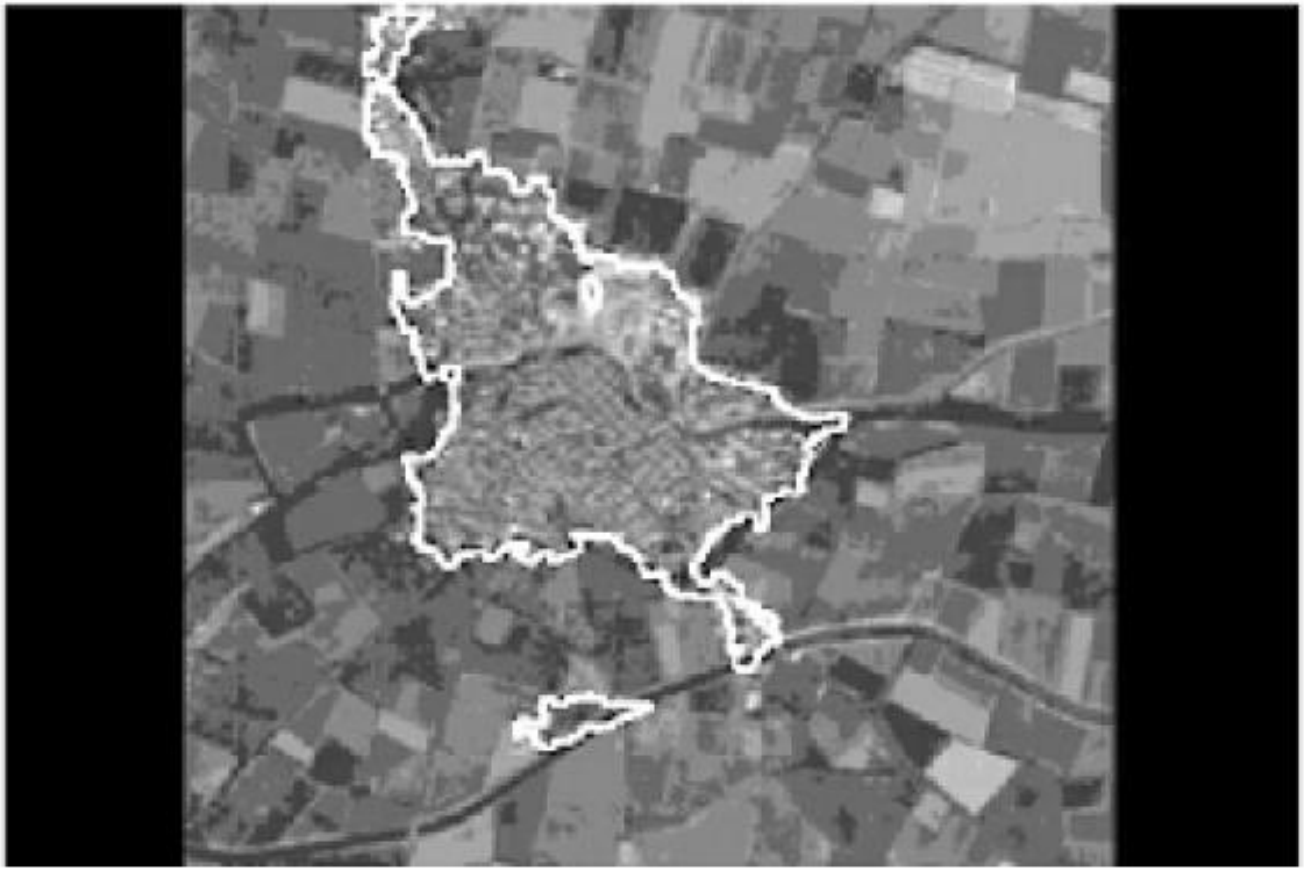
Color Enhancement

Original Images

Enhanced Images

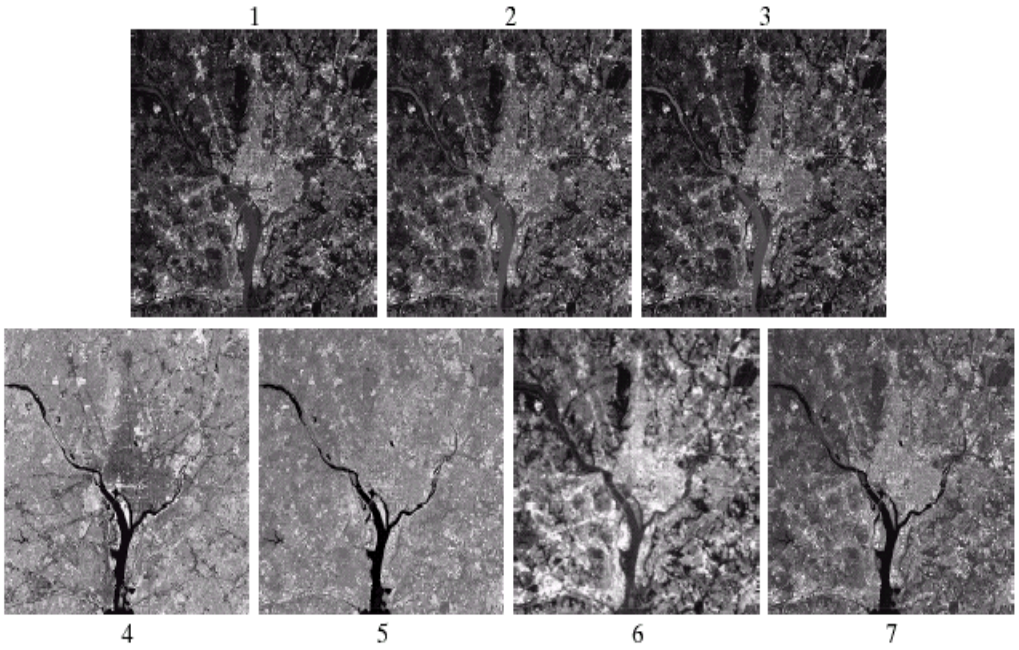
Area Classification

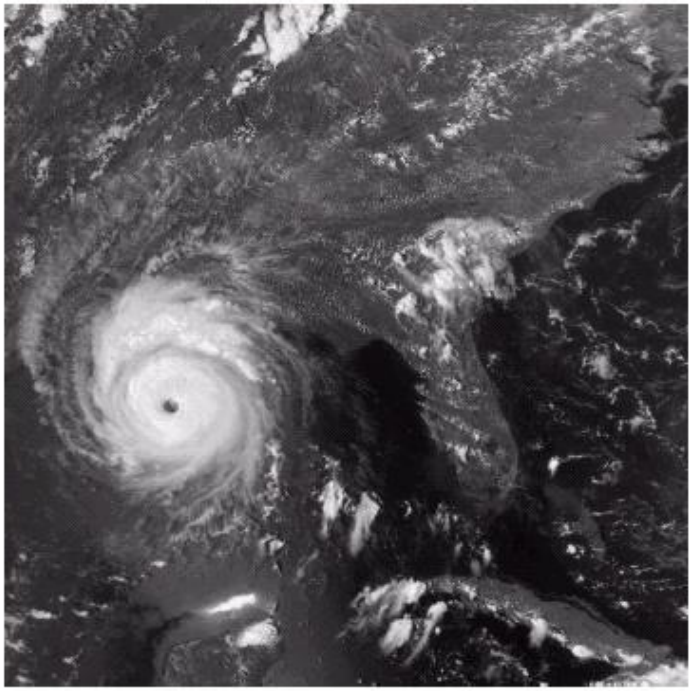
Extraction of settlement area from an aerial image



Geographic Information System

- Manipulation of Satellite Imagery
- Terrain Classification
- Weather Imaging





Digital Elevation Model

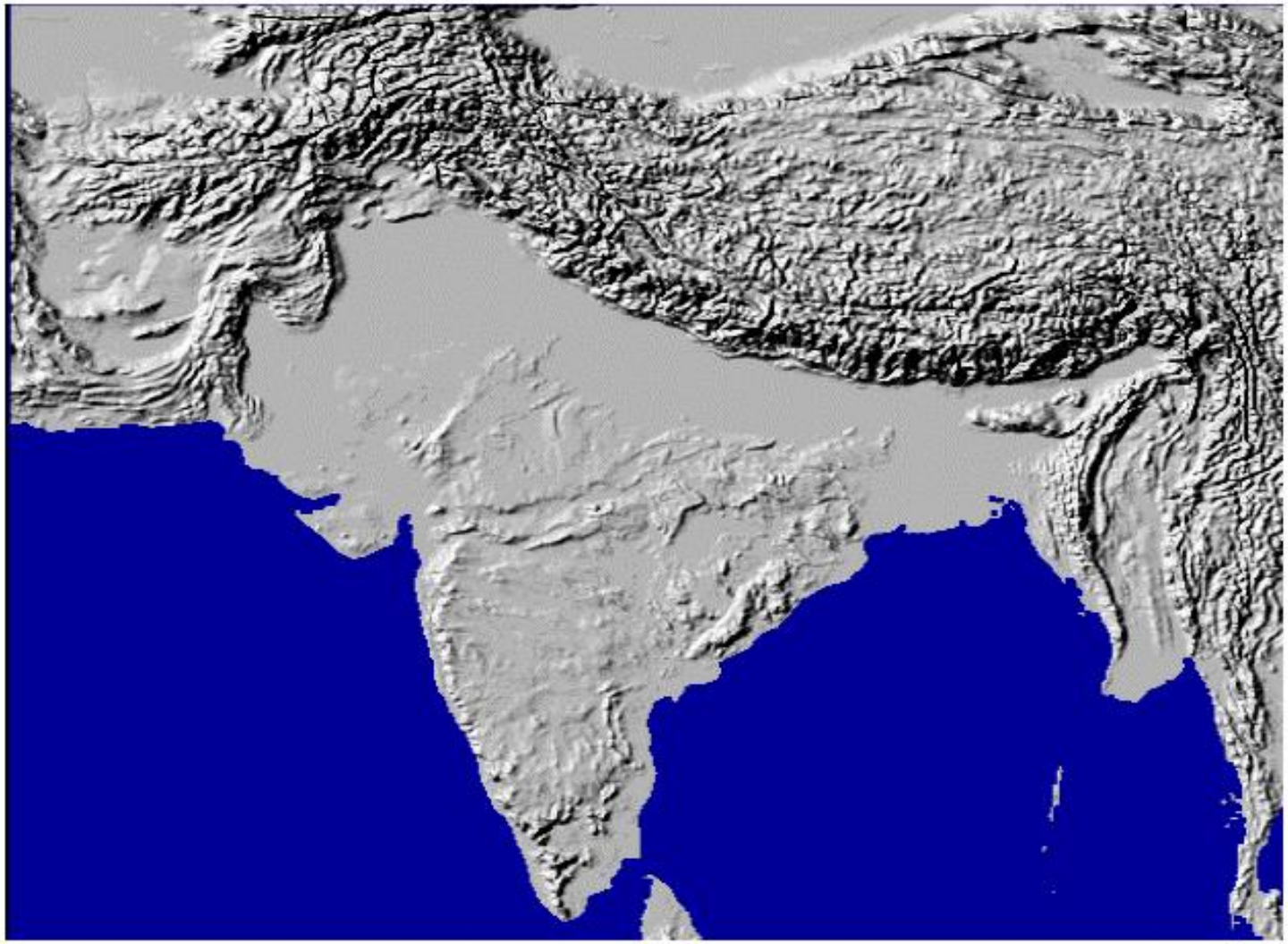
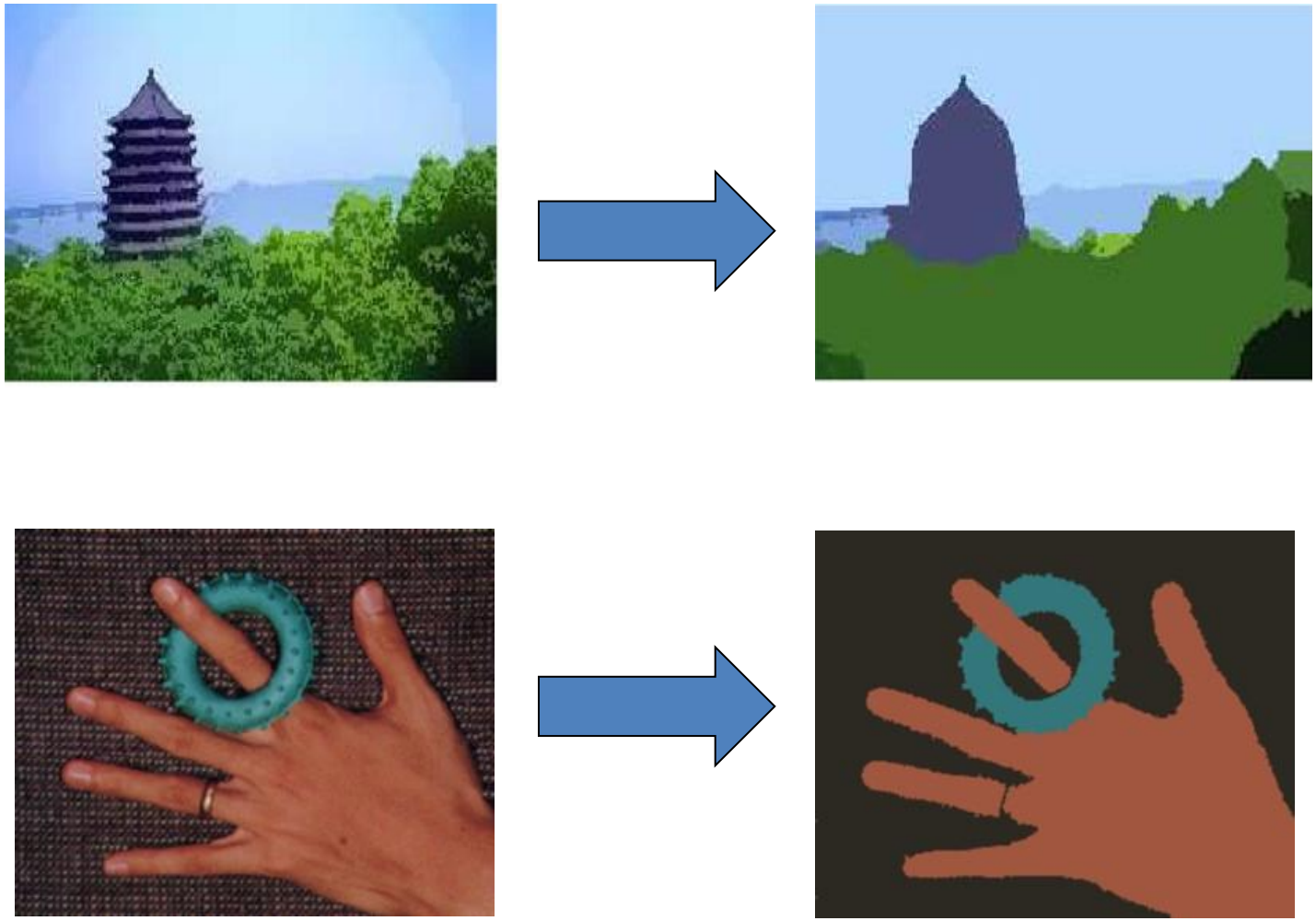
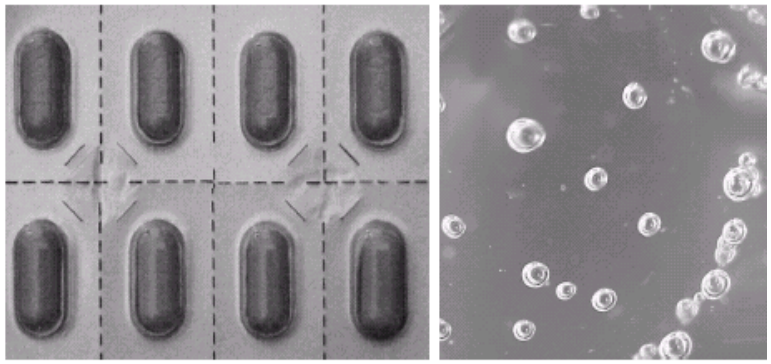
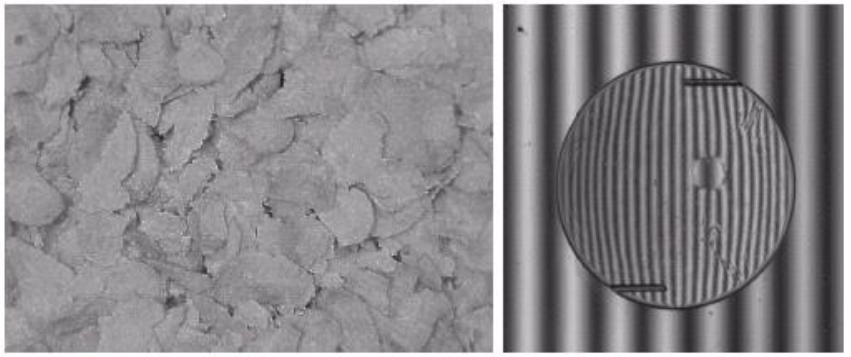


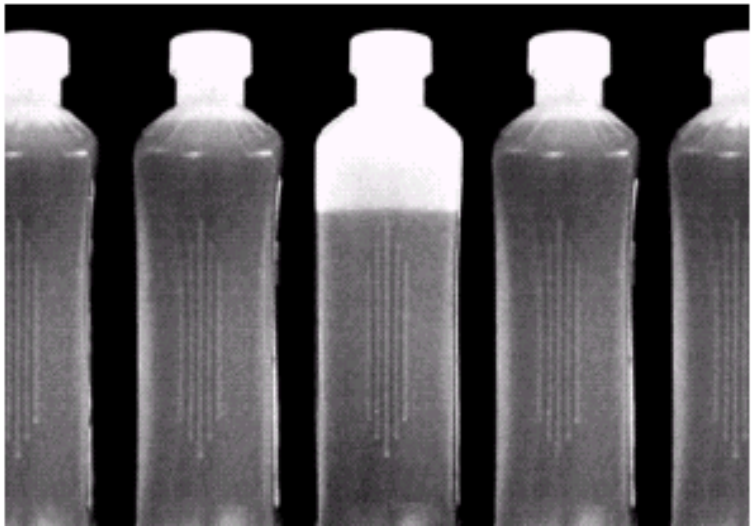
Image Segmentation

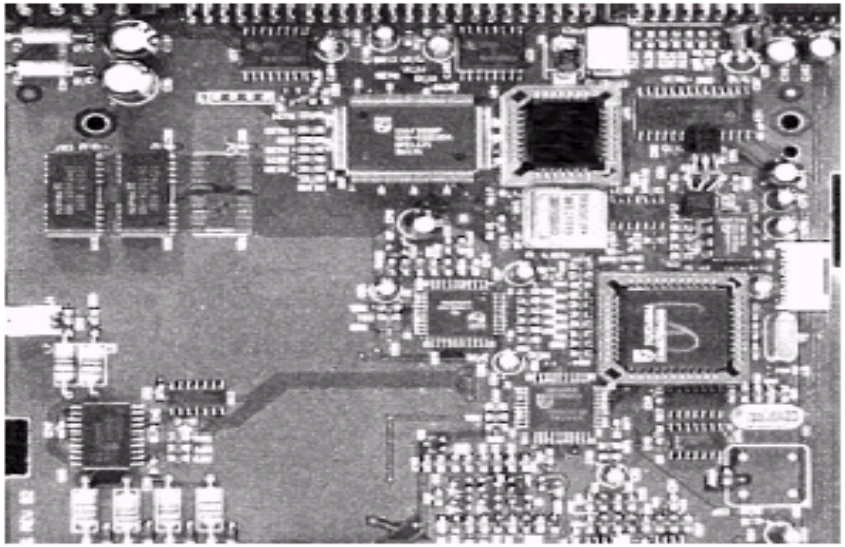


Industrial Automation

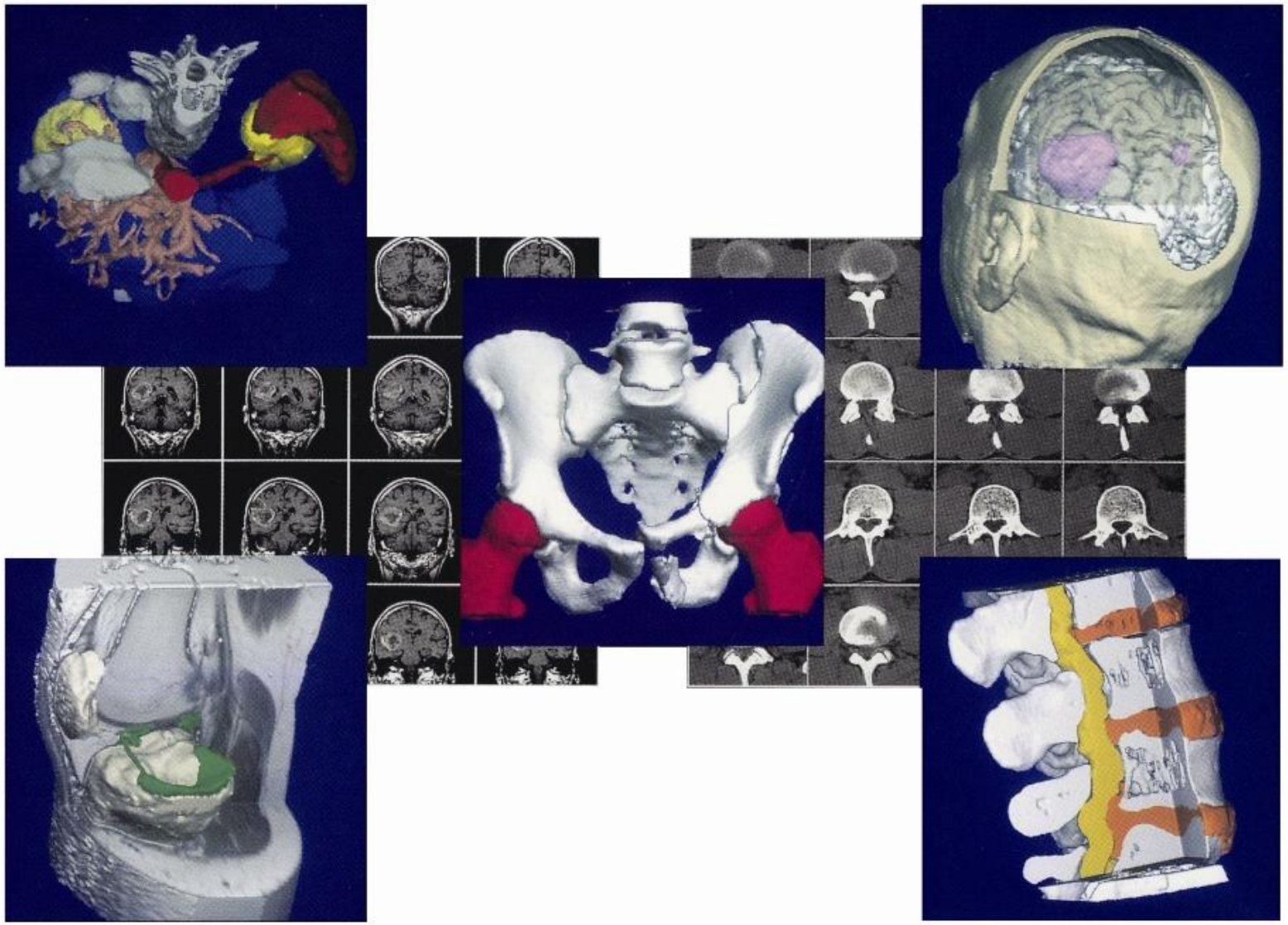








Medical Imaging



Face Detection

Face Detection

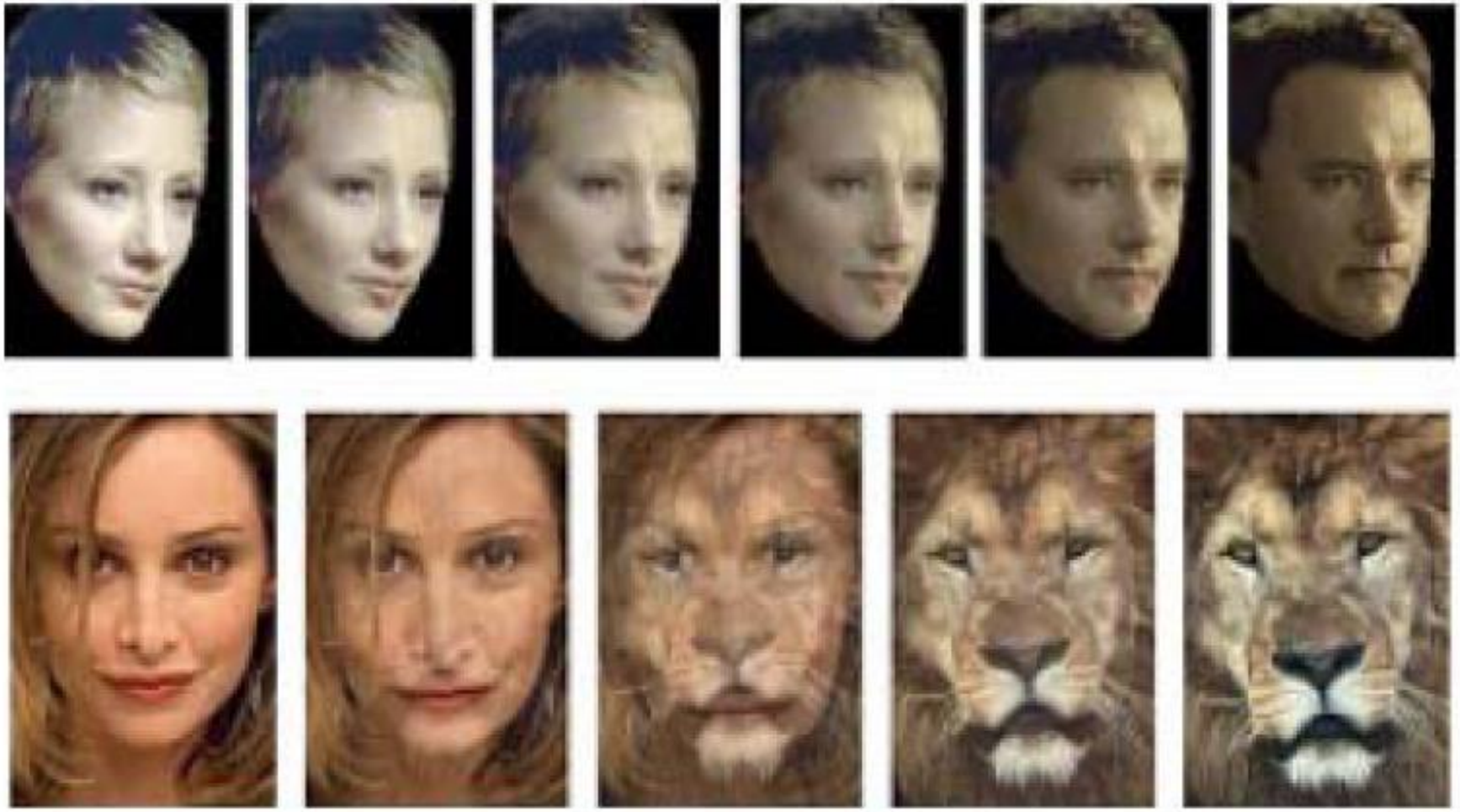
Emotion Classification

- Implicit customer feedback

Emotion Detection

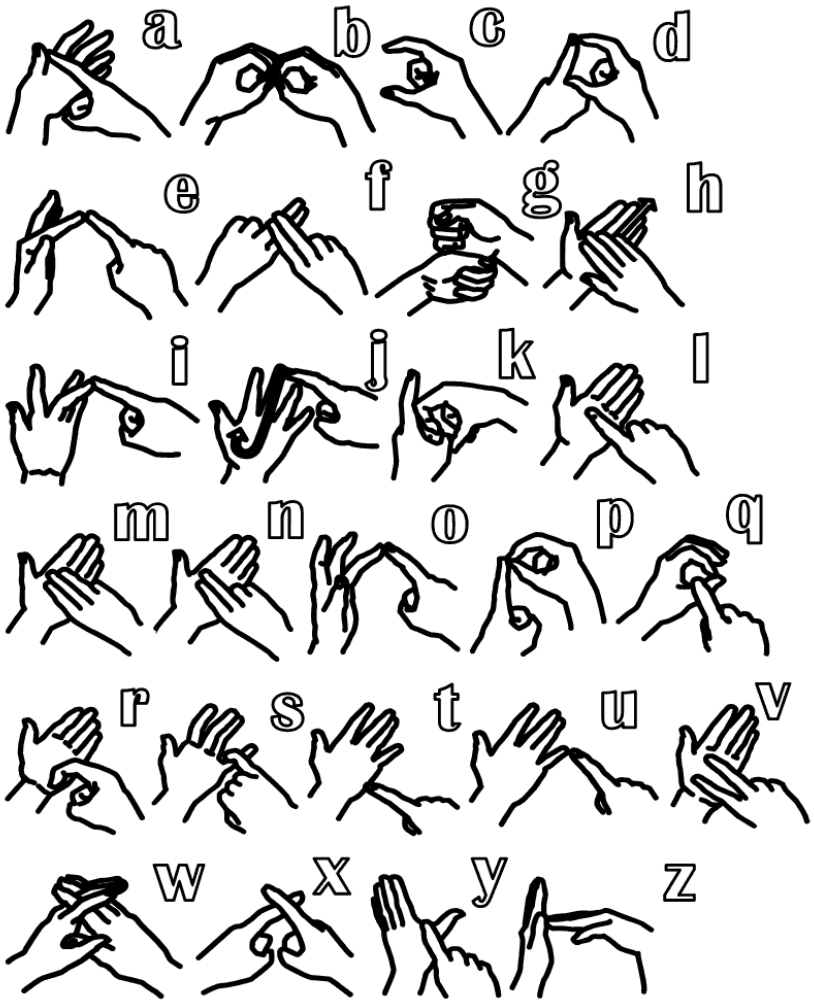
https://azure.microsoft.com/en-us/services/cognitive-services/emotion/

Morphing

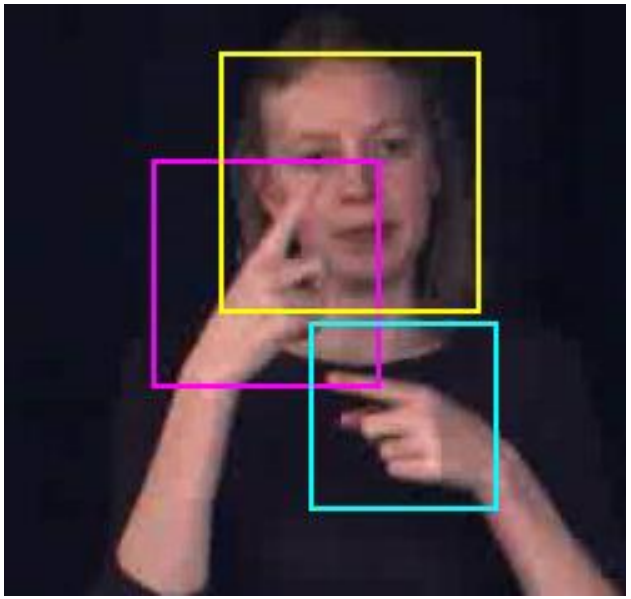


Morphing

Sign Language/Gesture Recognition



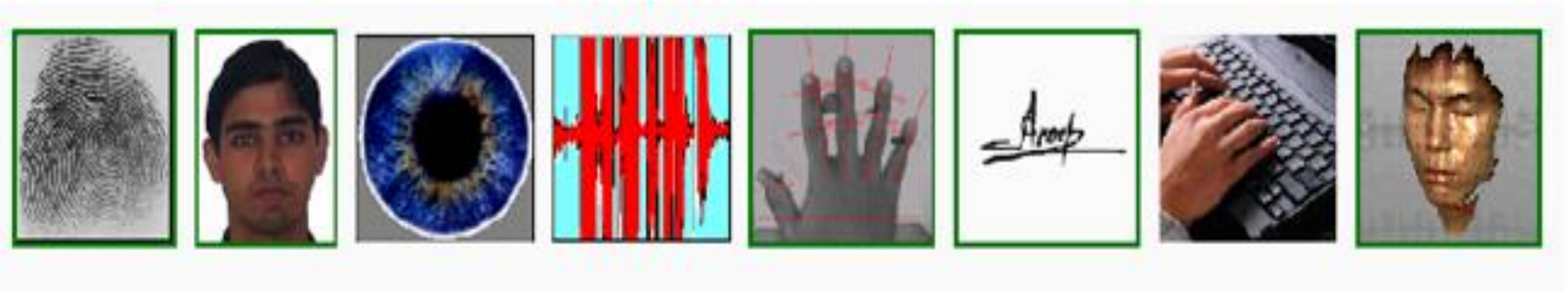
British Sign Language Alphabet



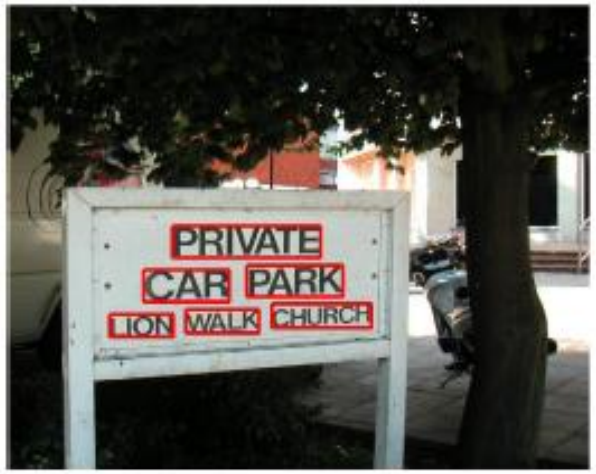
Lip Reading

Biometrics

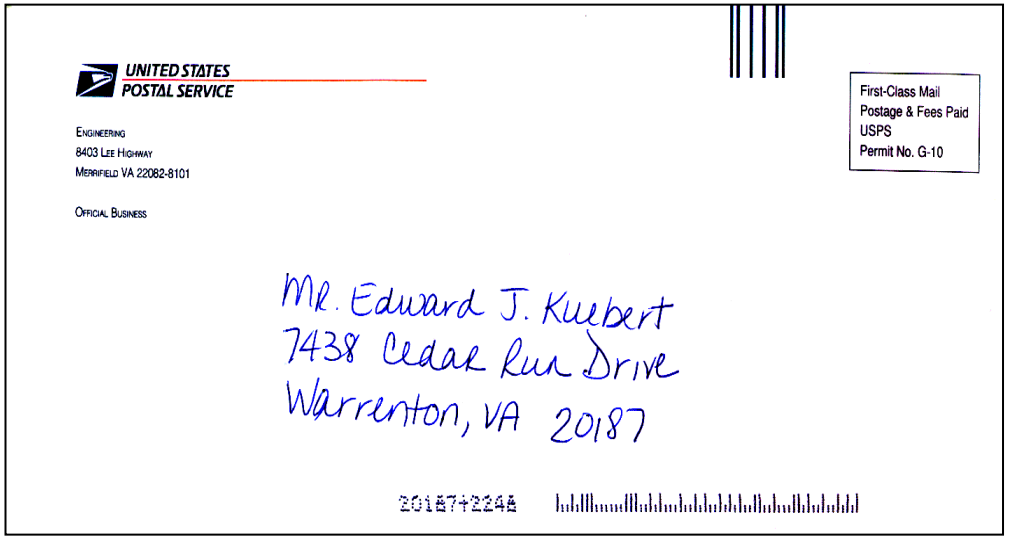
- Physiological Biometrics
  - Face, IRIS, DNA, Finger Prints
- Behavioral Biometrics
  - Typing Rhythm, Handwriting, Gait

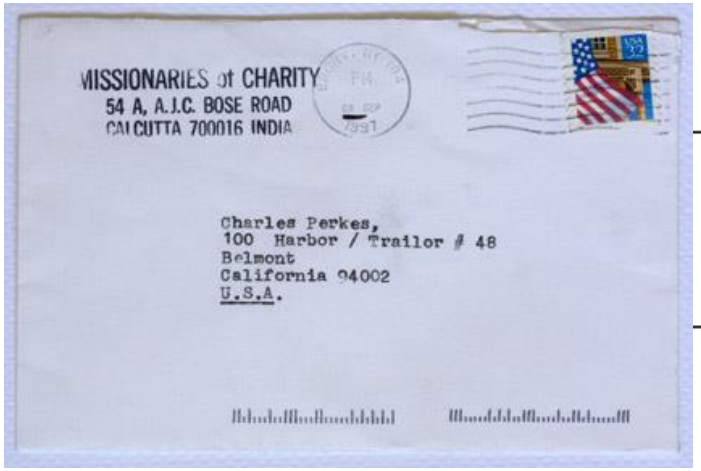


Text Recognition



Automated Mail Sorting





Content Based Video Retrieval

Common Operations on Images

(a) The original image

(b) Result after "sharperning"

Common Operations on Images

(a) The original image

(b) After removing noise

Common Operations on Images

(a) The original image

(b) After removing the blur

Overview

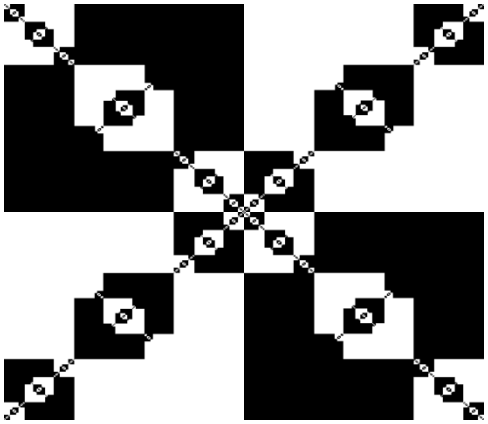
- **Basic Level**
  - Image Acquisition, Image Representation
  - Image Digitization, Quantization
  - Morphological Operations, Color Corrections
  - Enhancements, De-noising, Sharpening
- **Mid Level**
  - Segmentation, Registration
  - Compression, Data Hiding
  - Image Restoration, Blur Correction
  - Image Transforms
- **High Level**
  - Feature Detection, Feature Analysis
  - Intro to Biomedical Imaging
  - Classification

Outline *(Subject to Modifications)*

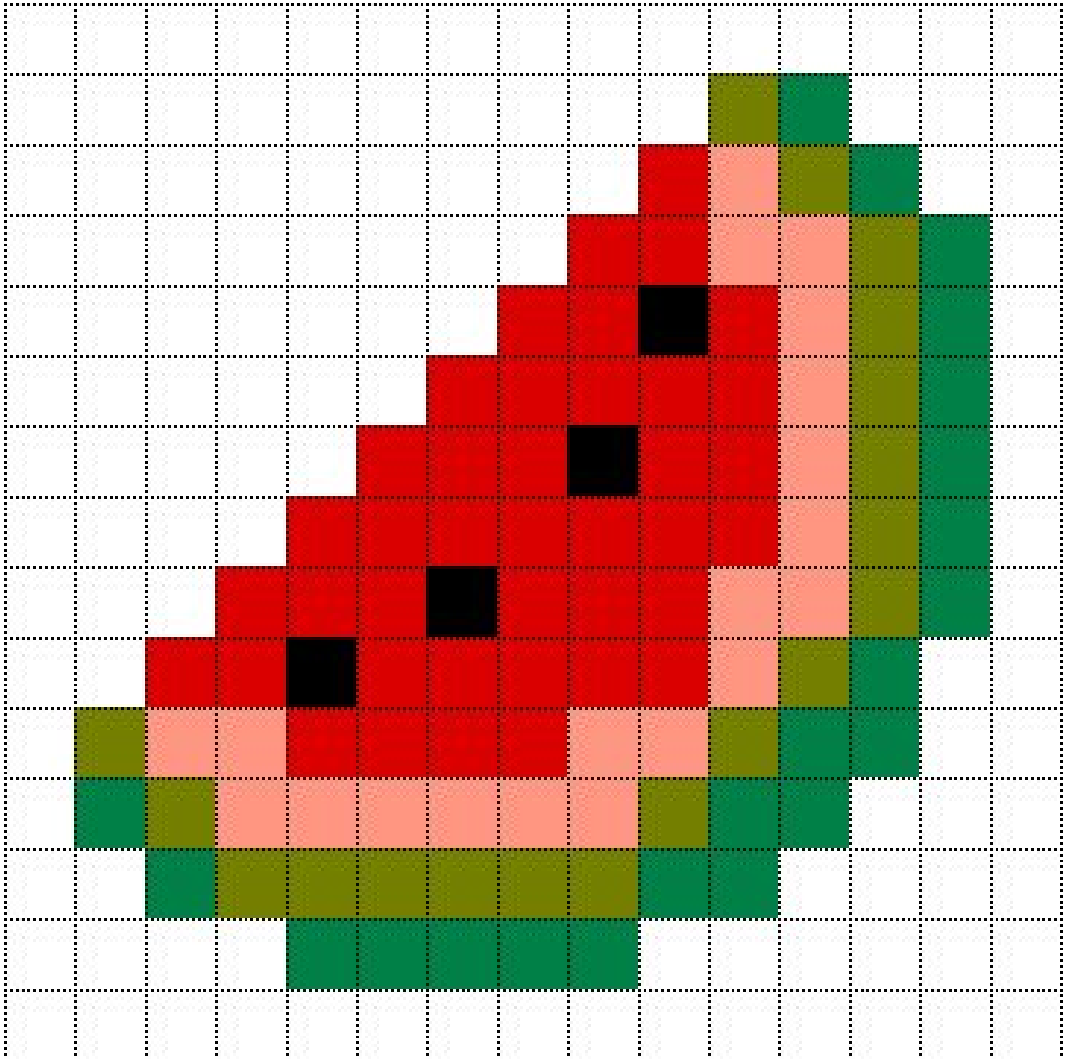
- Image Fundamentals
- Sampling, Quantization, Interpolation
- Intensity Corrections, Color Processing
- Morphological Operations
- Transforms
- Restoration
- Compression
- Segmentation
- Image Analysis
- Feature Detection and Analysis

Types of Images

- Binary
- Gray Scale
- Color
- Indexed

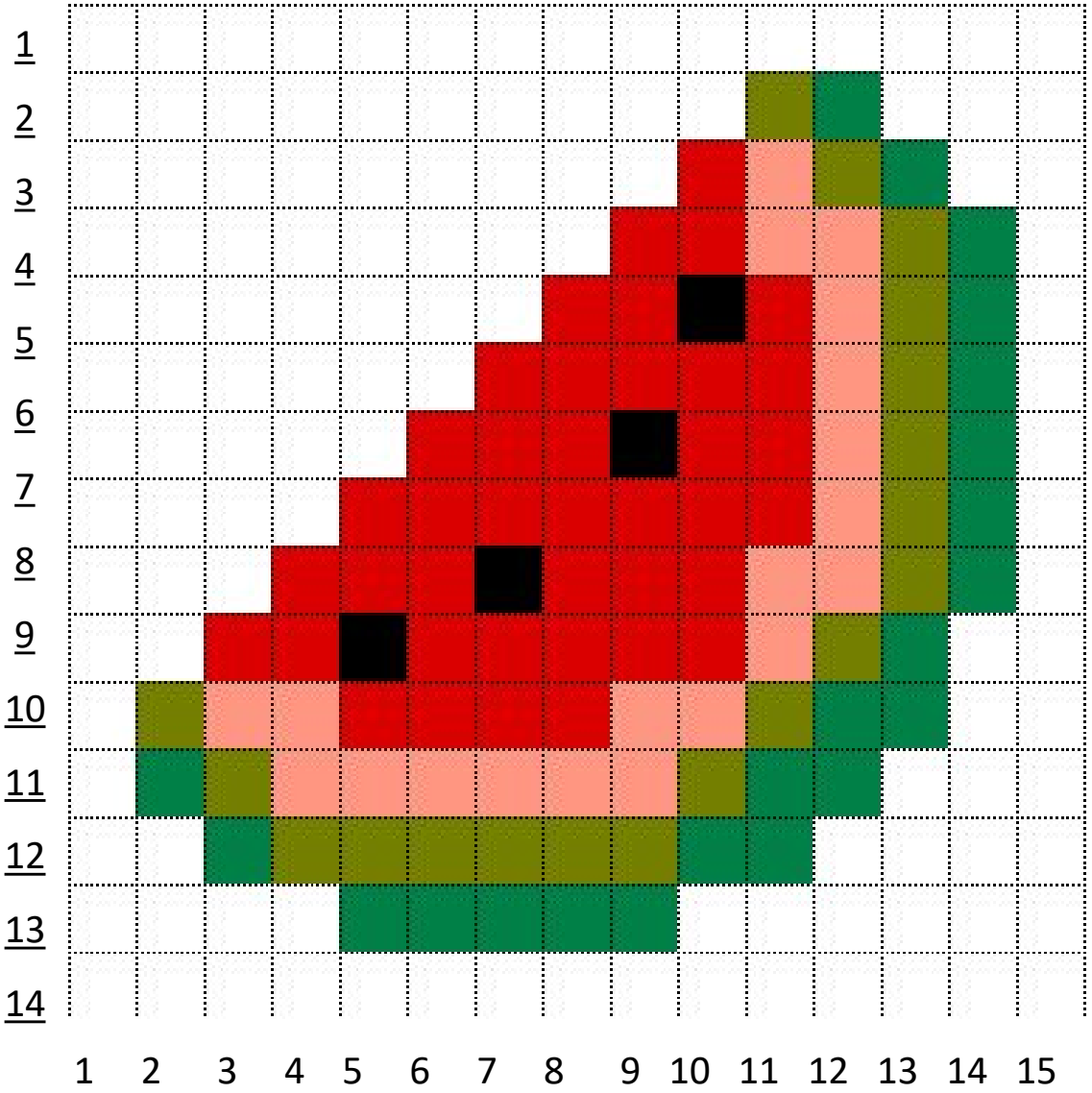


Pixels



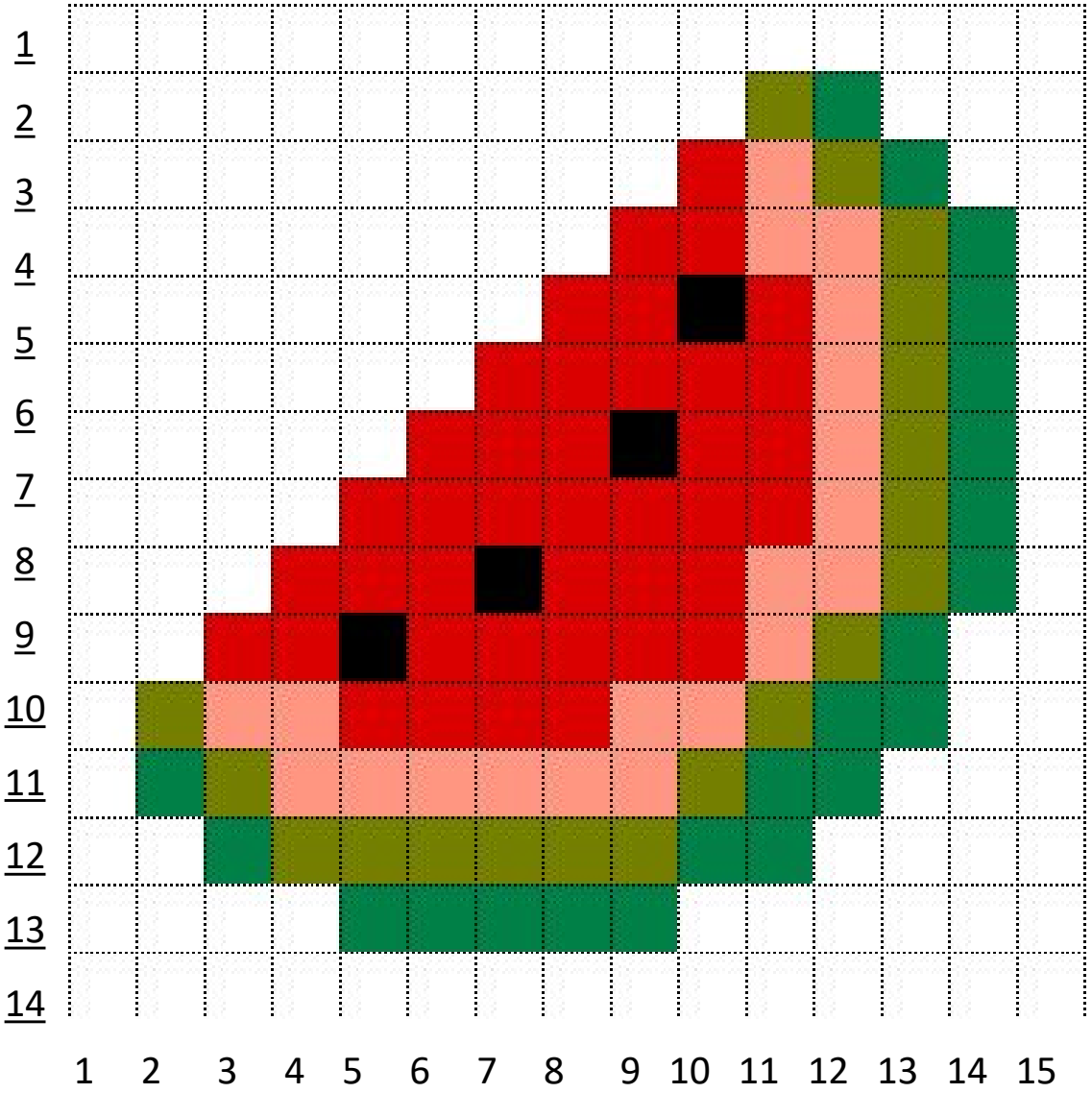
Pixels

Size of image:
? rows,
? columns



Pixels

Size of image:
14 rows,
15 columns



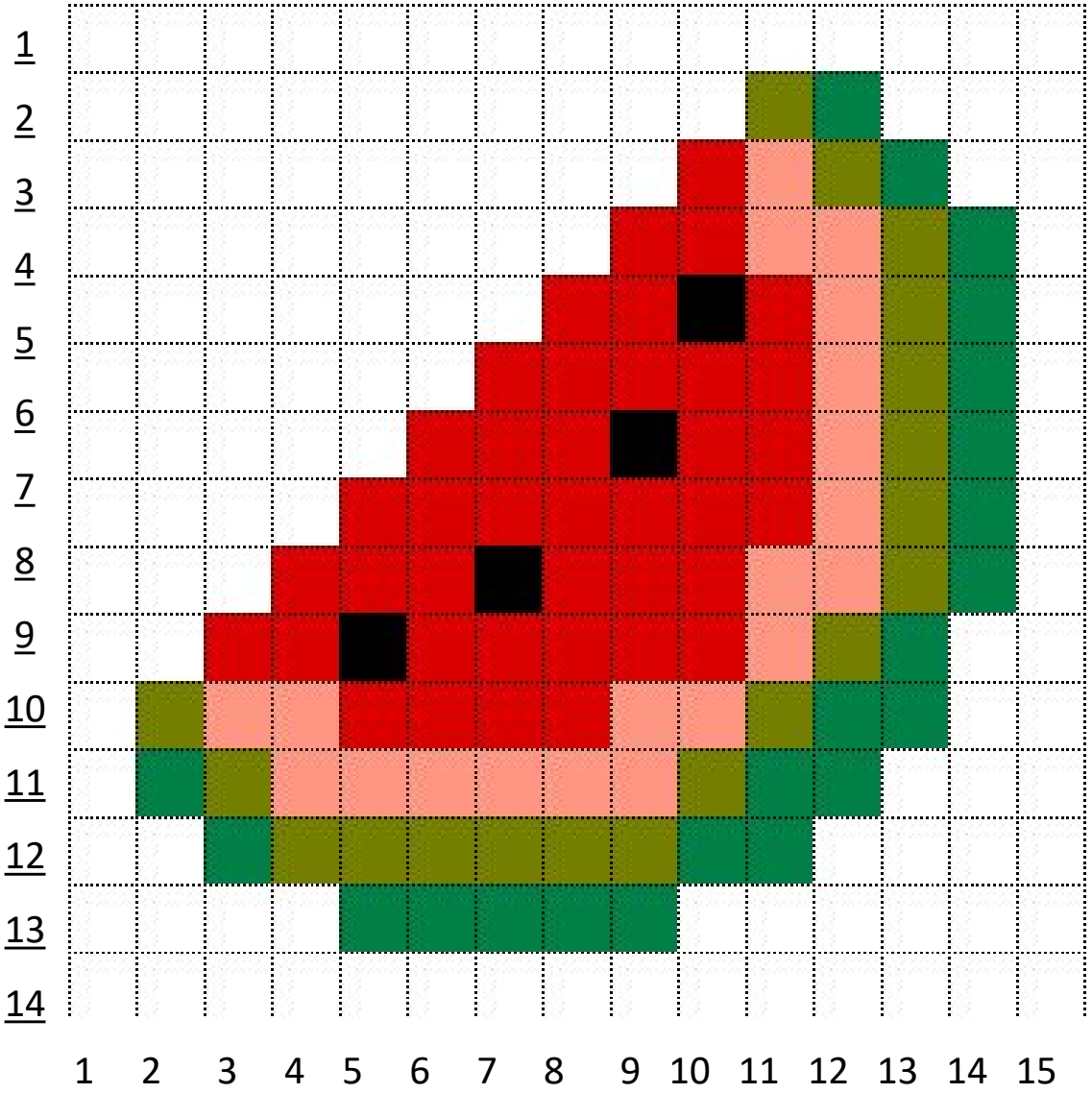
Pixels

Size of image:

14 rows,
15 columns

Image Color:

R G B



Pixels

NUST

Size of image:
14 rows,
15 columns

Image Color:
R G B

Red: 8 bits
Green: 8 bits
Blue: 8 bits

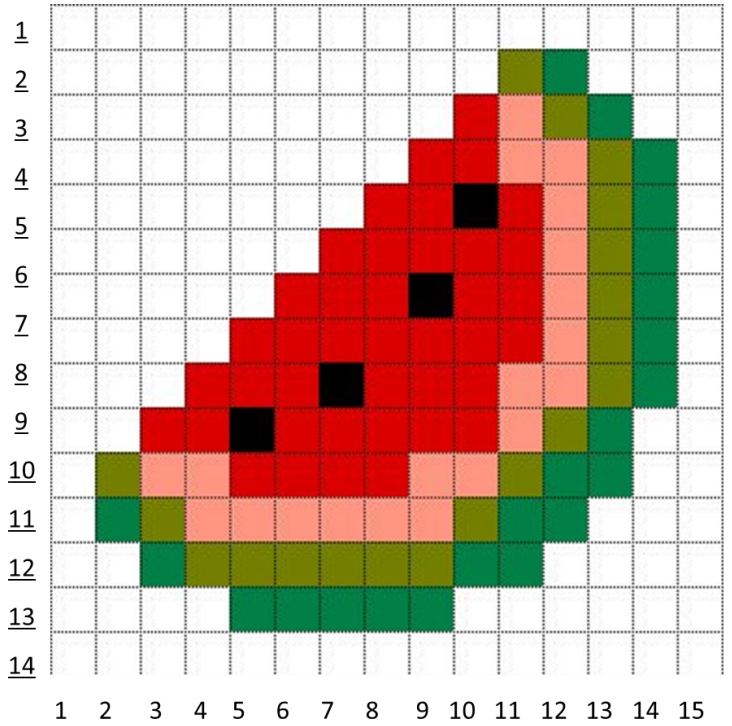


Image LxN pixels, 2^B gray levels, c color components

Storage size of image=?

$$Size = LxNxBxc$$

Pixels

Size of image:
14 rows,
15 columns

Image Color:
R G B

Red: 8 bits
Green: 8 bits
Blue: 8 bits

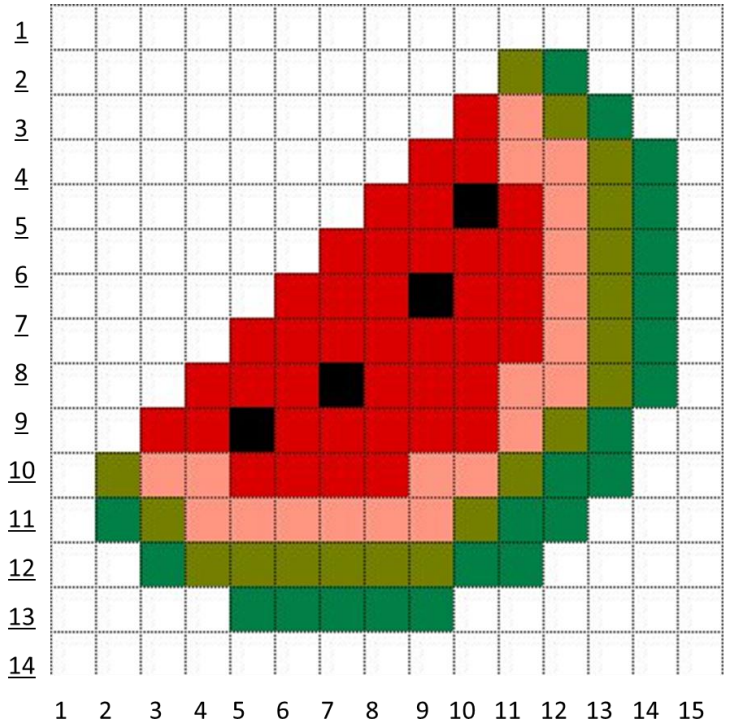


Image LxN pixels, 2^B gray levels, c color components

Storage size of image=?

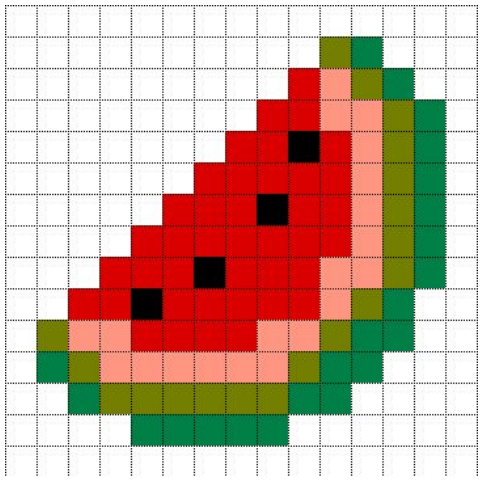
$$Size = LxNxBxc$$

14*15*8*3

Image Storage Requirements

Image LxN pixels, 2^B gray levels, c color components

$$Size = LxNxBxc$$



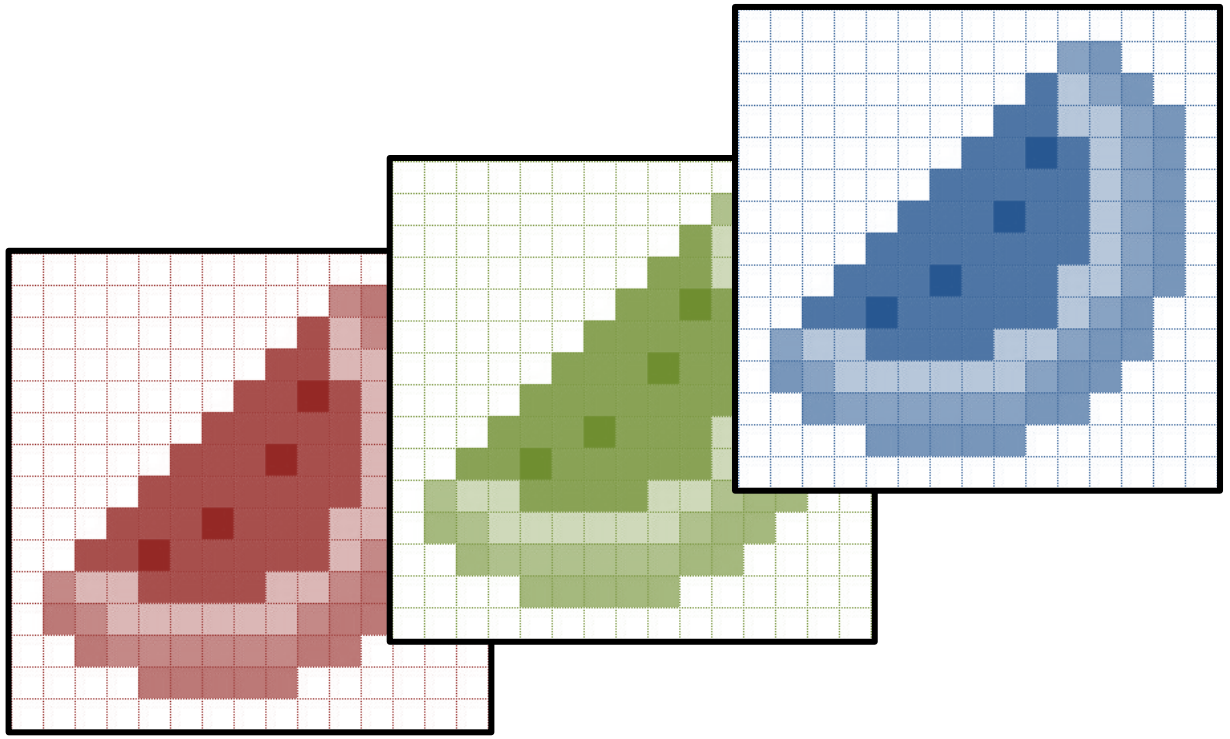


Image Storage Requirements

Image LxN pixels, 2^B gray levels, c color components

$$Size = LxNxBxc$$

- *Example: L=N=512, B=8, c=1 (i.e., monochrome)*

  Size = 2,097,152 bits (or 256 kByte)

- *Example: LxN=1024x1280, B=8, c=3 (24 bit RGB image)*

  Size = 31,457,280 bits (or 3.75 MByte)

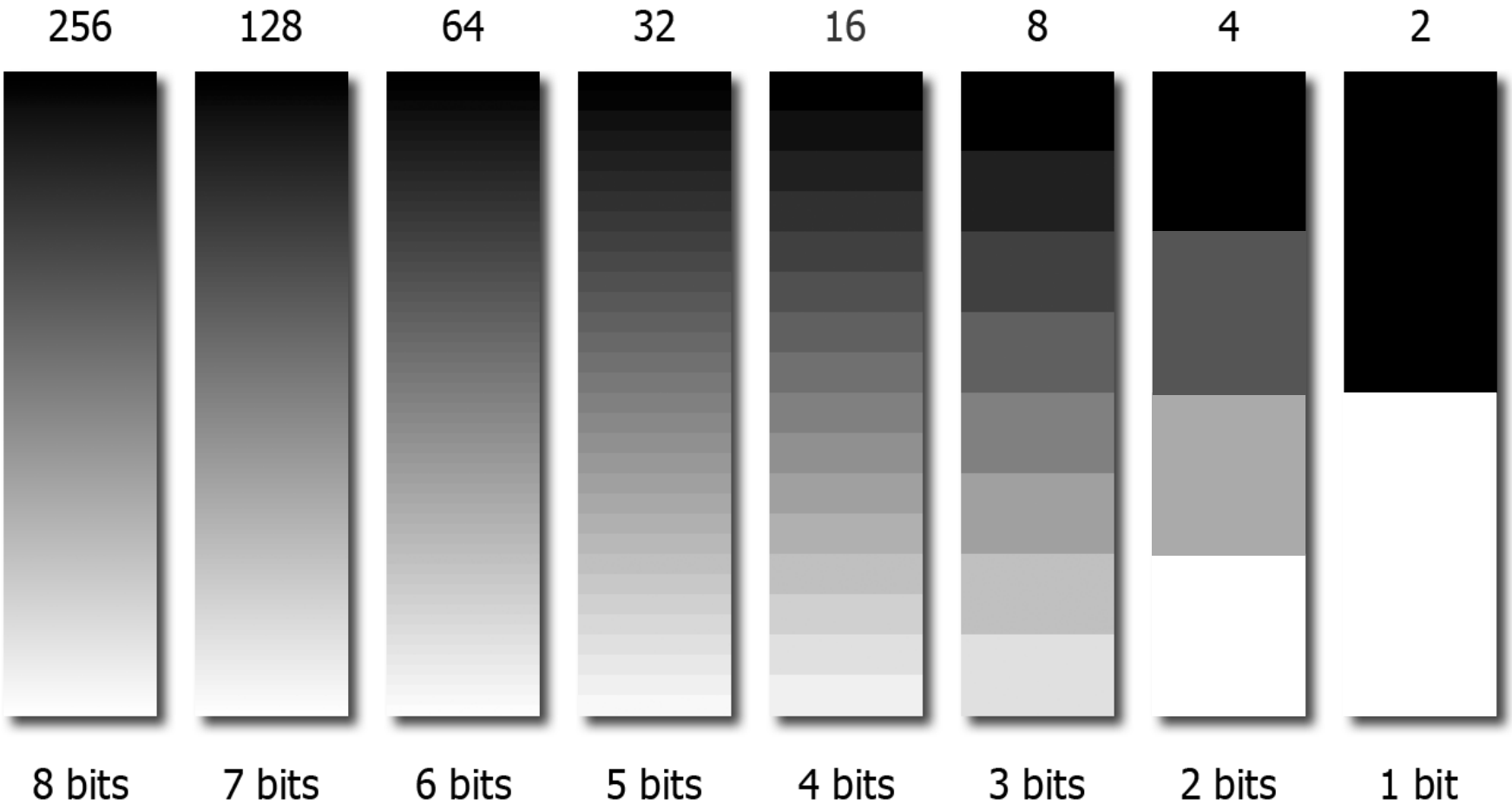
Introduction

- An image is a 2-dimensional function f_{xy} where x and y are the spatial coordinates, and f_{xy} is the intensity of the image at that point.

- A digital image is the representation of a continuous image f(x,y) by a 2-d array of discrete samples. The amplitude of each sample is quantized to be represented by a finite number of bits.

- Each element of the 2D array of samples is called a pixel (for 'picture element')
  - Color Images have 3 values per pixel.
  - Monochromatic Images have 1 value per pixel.

Intensity Resolution



Intensity Resolution

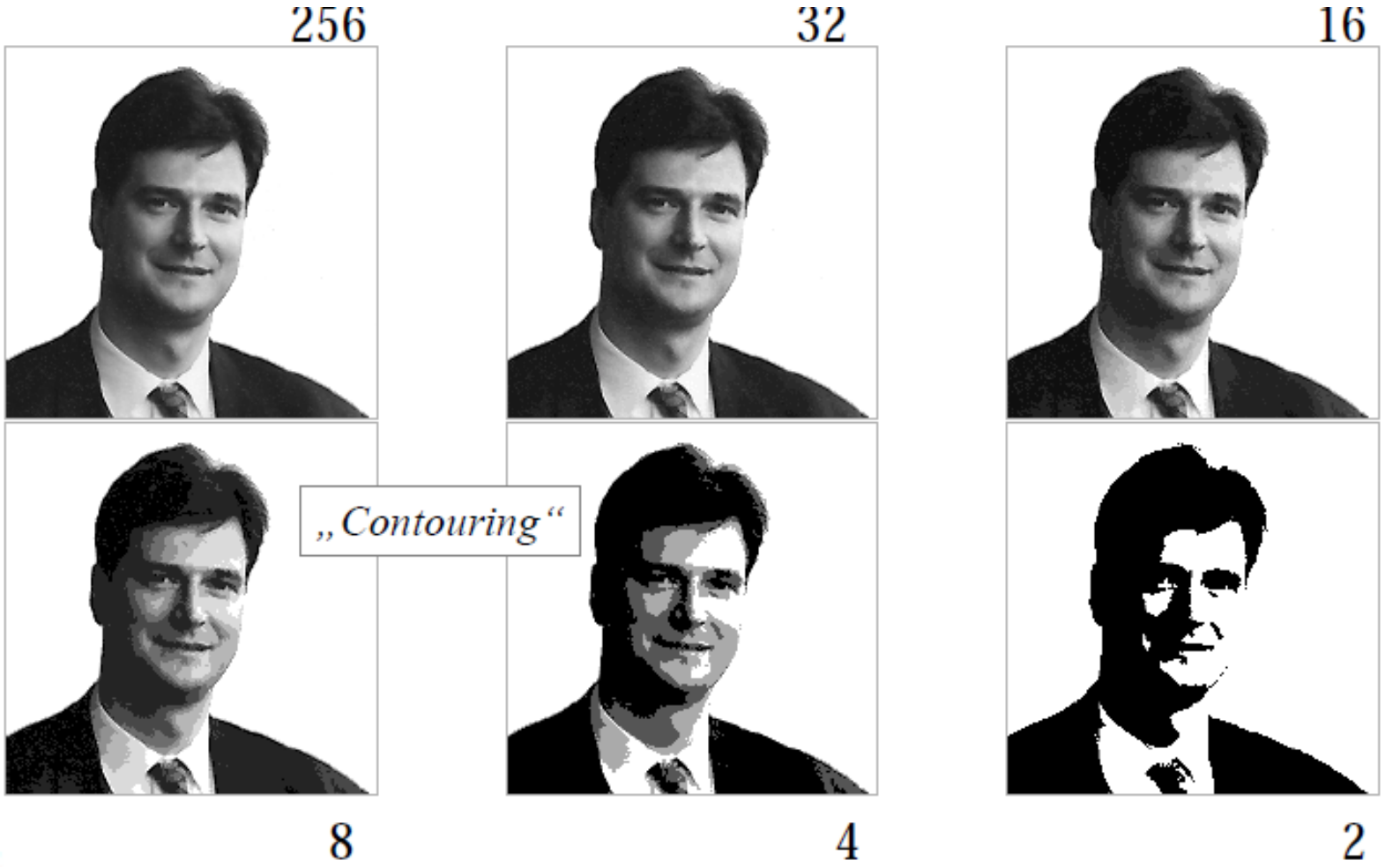


Image Representation

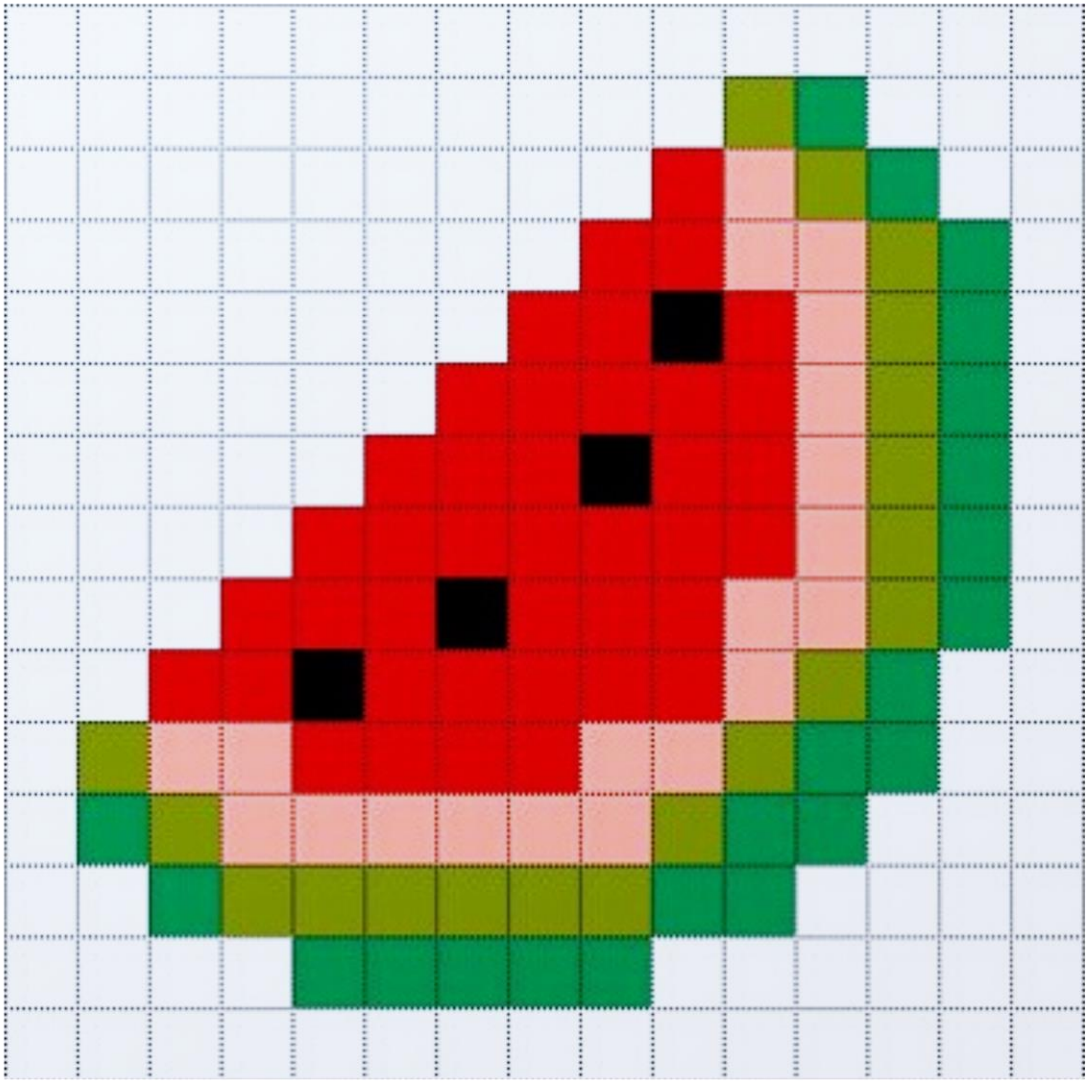


Image Representation

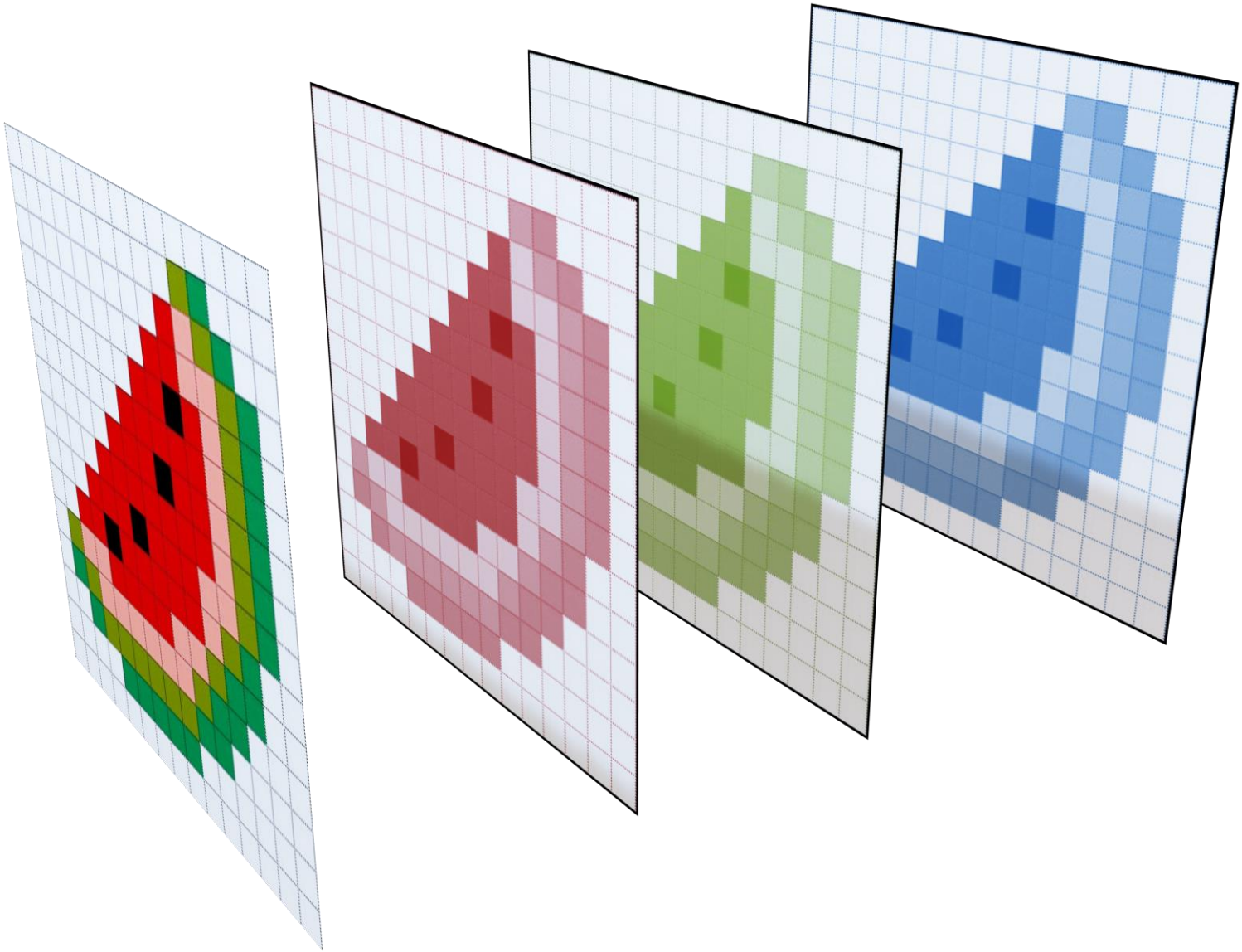


Image Representation

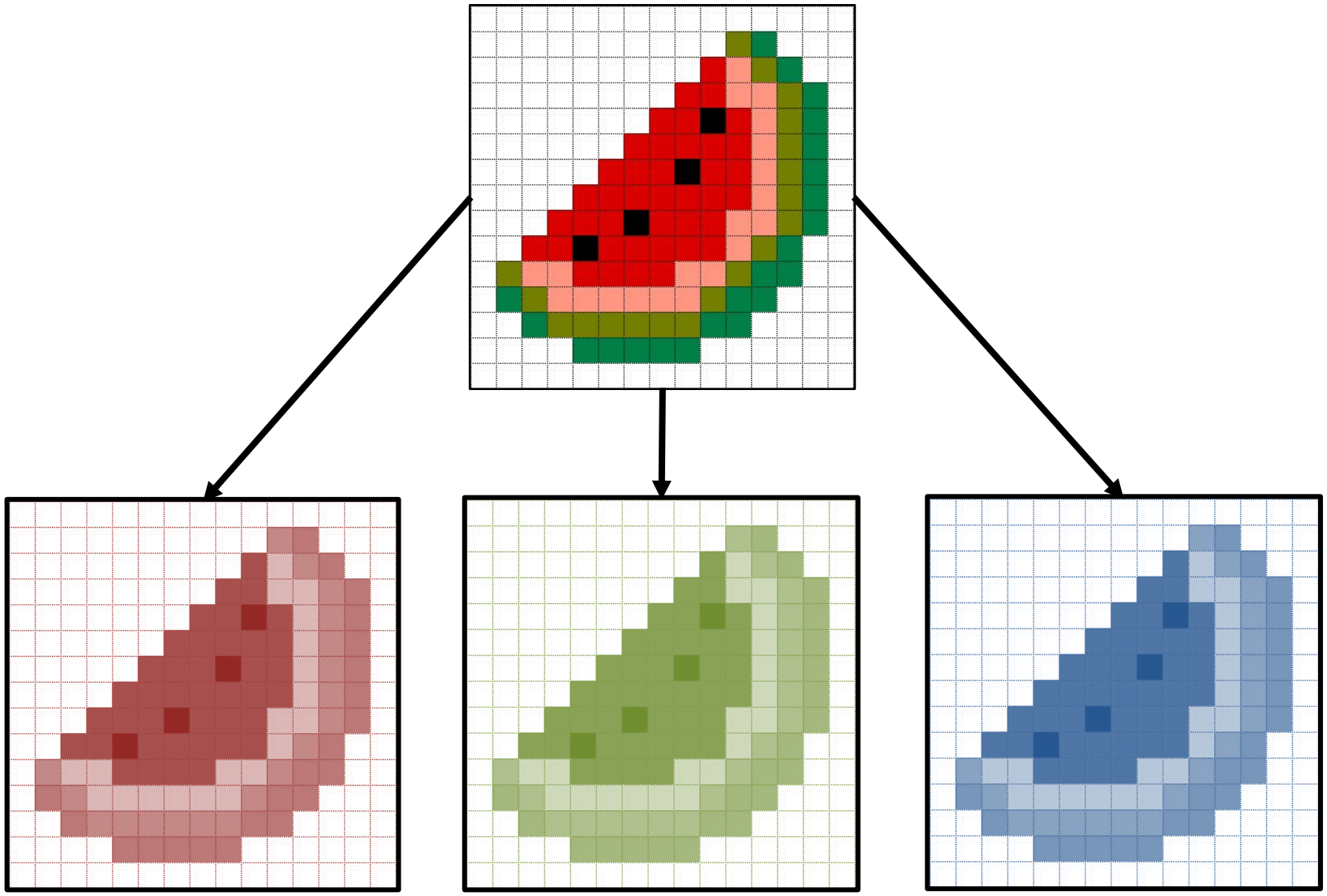


Image Representation

49	55	56	57	52	53
58	60	60	58	55	57
58	58	54	53	55	56
83	78	72	69	68	69
88	91	91	84	83	82
69	76	83	78	76	75
61	69	73	78	76	76

Red

64	76	82	79	78	78
93	93	91	91	86	86
88	82	88	90	88	89
125	119	113	108	111	110
137	136	132	128	126	120
105	108	114	114	118	113
96	103	112	108	111	107

Green

66	80	77	80	87	77
81	93	96	99	86	85
83	83	91	94	92	88
135	128	126	112	107	106
141	129	129	117	115	101
95	99	109	108	112	109
84	93	107	101	105	102

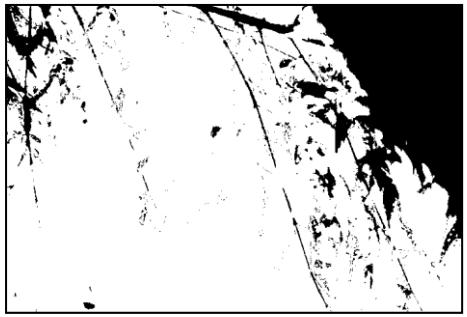
Blue

RGB -> Gray -> Binary

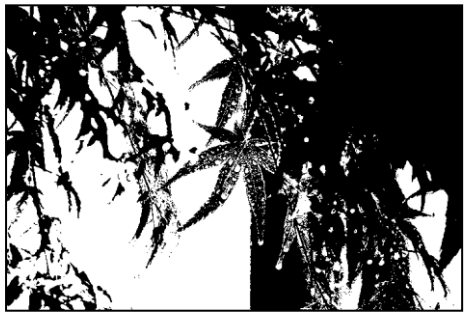
I = imread('rain.jpg') I -> 480x720x3

G = rgb2gray(I);

B = im2bw(G, level);



Level = 0.1



Level = 0.3

Level = 0.5

R-G-B Color Components

```
G = I;
G(:,:,1) = 0;
G(:,:,3) = 0;
```

R-G-B Color Components

RGB -> RBG

```
I(:,:,2) = B(:,:,3);
I(:,:,3) = G(:,:,2);
```

Resolution

- How many samples and gray levels are required for a good approximation?
- Quality of an image depends on number of pixels and number of gray-levels.
- The more these parameters are increased, the closer the sampled/quantized array approximates the original image.
- But storage and processing requirements increase rapidly as a function of N, M, and k.

Resolution

Depends on what is in the image and what you would like to do with it.

The picture on the right is fine for counting the number of cars, but not for reading the number plate.

End
Introduction